INFLUENCE OF THE TRAINING SYSTEM ON THE AGRONOMIC BEHAVIOR AND GRAPE COMPOSITION OF ALBARIÑO IN RÍAS BAIXAS APPELLATION

INFLUENCE DU SYSTÈME DE CONDUITE SUR LE COMPORTEMENT AGRONOMIQUE ET SUR LA COMPOSITION DES RAISINS DU CÉPAGE ALBARIÑO DANS L'APPELLATION D'ORIGINE RÍAS BAIXAS

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Abstract

Albariño is the most important grape variety in the Rías Baixas Appellation (Galicia, Spain), and the quality of its wines is worldwide renowned. The training system most commonly used for growing Albariño is the overhead trellis, also called "parral" in Spanish. This system allows high levels of light interception, with bunches not exposed. Canopy management is not easy hence leaf density might become excessive in vigorous vineyards. The aim of this study was to evaluate the performance of Albariño cultivar when using training systems other than the parral. In the experimental vineyard Pe Redondo, Martín Códax Winery, four different training systems were subjected to study over a period of four years: Parral (P), Geneve Double Courtain (GDC), Scott-Henry (SH), and Vertical Shoot Positioning (VSP). Yield, number of bunches per shoot, bunch weight and berry weight values were determined at harvest. Different must composition parameters were also measured at harvest: pH, titratable acidity, and concentrations of sugar, malic acid, tartaric acid, free amino nitrogen, and potassium. Pruning weight was determined in winter. Bearing in mind that there were small differences in the number of shoots per square meter, GDC was the training system with the highest yield as it had the highest number of bunches per shoot and bunch weight, followed by Parral, SH and VSP. The division of the canopy -GDC and SH- contributed to vigour reduction as well as the increase of Ravaz index. Regarding berry composition, the concentration of malic acid and titratable acidity were both higher in Parral, followed by VSP, SH and GDC, due to increasing values of light exposure and higher rates of malic acid degradation. The concentration of free amino nitrogen in must decreased with vigour reduction. These results may be of help for grape growers of Rías Baixas appellation, in relation to pursued objectives on grape quality and yield, when designing new vineyards with training systems different to Parral.

Keywords : *cv Albariño, training system, yield components, grape composition*

Resumé

Albariño est le plus important cépage de l'appellation Rias Baixas (Galice, Espagne), et la qualité de ses vins est reconnue mondialement. Le système de conduite le plus couramment utilisé pour la culture Albariño est le "parral". Ce système permet des niveaux élevés d'interception de la rayonnement solaire, avec des grappes pas exposés. La gestion du feuillage n'est pas facile donc la densité de la feuille pourrait devenir excessive dans les vignes vigoureuses. Le but de cette étude était d'évaluer la performance du cépage Albariño lors de l'utilisation des systèmes de conduite autres que le parral. Dans le vignoble expérimental Pe Redondo, Martín Códax Cave, quatre différents systèmes de conduite ont été soumis à l'étude sur une période de quatre ans: Parral (P), Geneve Double Courtain (GDC), Scott-Henry (SH), et Espalier (VSP). Le rendement, le nombre de grappes par rameaux, le poids de la grappe et le poids de baies ont été déterminés à la vendange. Différents paramètres de composition de must ont également été mesurés à la vendange: pH, acidité totale, et les concentrations de sucre, acide malique, acide tartrique, azote assimilable, et le potassium. Poids de bois de taille élagage a été déterminé en hiver. Gardant à l'esprit qu'il y avait de petites différences dans le nombre de rameaux par mètre carré, GDC était le système de conduite avec le plus haut rendement comme il l'avait le plus grand nombre de grappes par rameaux et de poids de la grappe, suivis par Parral, SH et VSP. La division de feuillage -GDC et SH- a contribué à la réduction de la vigueur ainsi que l'augmentation de l'indice Ravaz. En ce qui concerne la composition des baies, la concentration de l'acide malique et l'acidité totale étaient tous deux supérieurs à Parral, suivie par VSP, SH et GDC, en raison de l'augmentation des valeurs d'exposition au rayonnement solaire et des taux plus élevés de la dégradation de l'acide malique. La concentration de l'azote assimilable dans le moût a diminué avec la réduction de la vigueur. Ces résultats peuvent être d'une aide pour les producteurs de Rias Baixas appellation, par rapport aux objectifs poursuivis sur la qualité du raisin et le rendement, lors de la conception de nouveaux vignobles avec différents systèmes de conduite à Parral.

Mots-clés : cv Albariño, systèmes de conduite, composantes du rendement, composition des raisins

1. Introduction

Albariño is the most important grape variety in the Rías Baixas Appellation (Galicia, Spain). In 2013, Albariño accounted for 97% of the total production from Rías Baixas Appellation (C.R.D.O. Rías Baixas, 2013). The "parral" (the way overhead trellis is referred to in Spanish) is the most common training system in the region where Albariño is grown. One of the advantages of using this system is the high level of light interception. Apart from this, the grape bunches are at a distance from the foliage and well above the soil, this reducing the risk of bunch rotting in a region climate conditions that favour the development of fungal diseases. These conditions also promote vegetative growth and vigour, and the "parral" is a way of avoiding certain practices such as shoot positioning and trimming, this without hindering other management practices.

Until now, there was no work done on training systems for Albariño rather than the "parral" in Rías Baixas Appellation. The present study aimed at assessing three different alternatives to the "parral" in order to know vegetative growth, yield, and grape composition variations. In two of the training systems -Geneve Double Courtain and Scott-Henry- the set canopy division aimed at vigour reduction and the improvement of vine microclimate. In the other training system -Vertical Shoot Positioning- the same objectives were pursued by increasing planting density and decreasing shoot density (shoots per meter of row).

2. Materials and methods

Experimental vineyards

The study was carried out during 2009, 2010, 2011 and 2013, in the experimental vineyard "Pe Redondo", from Martín Códax Winery, located in the municipality of Meis, Rías Baixas Apellation (Galicia, Spain, 42º 30' N, 8º 43' W, 145 m amsl). The area has maritime Mediterranean climate, humid, with mild winters, and warm summers. Average annual temperature is around 14.5 ºC; and average rainfall, 1400-1500 mm. The soils most representative of the area are Haplumbrept: deep ones, with acidic pH, rich in organic matter, and of a loamy texture.

Albariño vines grafted onto 420A were planted in 2003. Four training systems were assessed: Parral (P) or overhead trellis, Geneve Double Courtain (GDC), Scott-Henry (SH), and Vertical Shoot Positioning (VSP). The main characteristics of these systems are detailed in table 1. The experiment involved the four different training systems in a randomized complete block design with three replications.

All training systems were cane pruned, with bilateral disposition for GDC, SH and VSP. Weeds were controlled by mowing between rows and under the vines. During ripening, the vineyards were drip irrigated, with annual water dosages ranging from 900 to 1200 m^3/ha.

Table 1. *Characteristics of the experimental vineyards.*
Tableau 1. Caractéristiques des vignobles expérimentaux.

Training System	Inter-row distance (m)	In-row distance (m)	Trunk height (m)	Canopy division distance (m)
Parral	2.5	3.0	1.8	-
GDC	3.2	2.0	1.8	1.0 (horizontal)
SH	2.5	2.0	1.1	0.2 (vertical)
VSP	1.5	2.0	0.9	-

Experimental measurements

a) Weather conditions. Weather conditions during the study were measured by an automated meteorological station located in the plot. The reference evapotranspiration (ETo) value was calculated using the Penman–Monteith formula, as described in Allen et al. (1998). Berry weight and composition. At harvest, a sample of 100 berries was collected per replicate. The 100-berry samples were weighed and processed to carry out the analysis of the must. Titratable acidity to an end-point pH 8.2 (TA, g/L TH_2), pH, and the concentration of total soluble solids (TSS, ºBrix), malic acid (MH_2, g/L), tartaric acid (TH_2, g/L), free amino nitrogen (FAN, mg/L), and potassium (K, mg/L) were determined.

b) Yield components. The number of bunches and shoots as well as the crop yield at harvest were recorded for 4 vines per replicate in P, and 10 vines per replicate in GDC, SH and VSP. The number of bunches per shoot was calculated as the number of bunches/total number of shoots. The average bunch weight was obtained by dividing the total yield by the total number of bunches. The number of berries per bunch was determined as average bunch weight/berry weight (berries sampled for must composition).

c) Pruning weight. In winter, the number of shoots of 4 vines per replicate in P, and 10 vines per replicate in GDC, SH and VSP were counted; and pruning weight was measured. Average shoot weight was calculated as pruning weight divided by the number of shoots.

Data analysis

Two-way (training system x year) analysis of variance (ANOVA) was performed using SPSS v 15.0 statistical software (SPSS, Chicago, Illinois). Differences between treatments were assessed using the Duncan's multiple range test, with significance set at $P \leq 0.05$.

3. Results and discussion

Because of the different training systems design and management, slight differences regarding shoot density (shoots/m^2) were noted, with GDC and VSP differing by up to 15%. GDC was the training system with higher crop yield, followed by P, SH and VSP. Differences on yield were mainly due to bunch weight, higher in GDC and P, followed by SH and VSP. Bunch weight was determined by the number of berries, and not berry weight. There were no significant differences on the number of bunches per shoot (table 2).

Table 2. *Crop yield and yield components.*
Tableau 2. Rendement et les composantes du rendement.

Training System	Crop yield (t/ha)	Shoots/m^2	Bunches/shoot	Bunch weight (g)	Berries/bunch	Berry weight (g)
Parral	15.9 a	6.9 bc	2.01	122 a	99 ab	1.23
GDC	17.9 a	6.7 c	2.15	129 a	106 a	1.24
SH	15.8 ab	7.4 ab	2.00	109 b	91 b	1.19
VSP	13.3 b	7.9 a	1.96	88 c	73 c	1.22
TS	*	**	ns	***	**	ns
Year	***	***	ns	***	***	***
TS x Year	ns	ns	ns	*	ns	ns

TS: training system.
*,**,***,ns: significant at $p \leq 0.05$, 0.01, 0.001, or not significant, respectively.
Means separated at $p \leq 0.05$ by Duncan's multiple range test.

Vigour and vegetative growth were both lower in divided canopy training systems -GDC and SH-. SH showed lower vigour than GDC, probably due to its higher shoot density (table 3). Possibly because of the characteristics of P, which allow higher shoot lengths, this training system presented the highest vigour.

Table 3. *Vegetative growth, vigour and Ravaz index.*
Tableau 3. La croissance végétative, la vigueur et l'indice Ravaz.

Training System	Pruning weight (t/ha)	Shoots/m^2	Cane weight (g)	Ravaz index (kg/kg)
Parral	5.7 a	6.9 bc	84 a	3.1 c
GDC	3.8 b	6.7 c	68 b	4.9 a
SH	4.1 b	7.4 ab	55 c	4.0 b
VSP	5.6 a	7.9 a	75 a	2.6 d
TS	*	**	**	***
Year	**	***	***	***
TS x Year	ns	ns	ns	ns

TS: training system.
*,**,***,ns: significant at $p \leq 0.05$, 0.01, 0.001, or not significant, respectively.
Means separated at $p \leq 0.05$ by Duncan's multiple range test.

The systems with more exposed fruiting zones in spring -GDC and P- had a higher number of berries per bunch. It was even noted that fertility (clusters/shoot) was prone to be higher in GDC, although these differences were not statistically significant. Therefore light seemed to be a key factor on yield, due to its effect on floral differentiation throughout both the previous and current years. The work carried out by Reynolds and Vanden Heuvel (2009) gathers the results and conclusions from a significant number of studies done on training systems, some of which state the influence of light on bud fertility whereas others (Peterlunger *et al*. 2002 and Vanden Heuvel *et al*., 2004) found substantial differences on yield due to bunch weight, more specifically, number of berries per bunch.

Training systems showed to have an influence on the composition of Albariño grapes (Table 4). The concentration of malic acid was the highest in P, followed by VSP and SH, and the lowest in GDC. The greater the bunch exposure during ripening the lower the malic acid concentration. The higher temperature of exposed bunches is probably the factor that influenced the most malic acid degradation. Not only the position of the bunches in relation to the canopy but also the vigour seemed to have an influence on bunch exposure to light. Differences on total acidity were also noted. There were no major differences on tartaric acid concentration. The concentration of free amino nitrogen in must decreased with vigour reduction, with the GDC and SH showing the lowest values. Significant differences were found among the different training systems on the concentration of potassium in must, with SH having the lowest values, and P the highest ones. Despite having the greatest concentration of potassium, P was the training system with the lowest pH due to the high acidity levels of its grapes.

Table 4. *Must composition at harvest.*

Tableau 4. Composition des raisins à la récolte.

Training System	**TSS (ºBrix)**	**pH**	**TA (g/L TH_2)**	**TH_2 (g/L)**	**MH_2 (g/L)**	**K (mg/L)**	**FAN (mg/L)**
Parral	20.7	3.03 b	11.6 a	6.9	5.5 a	1963 a	438 a
GDC	20.9	3.07 a	9.5 c	6.3	3.6 c	1946 a	373 c
SH	20.7	3.06 a	9.8 bc	6.7	4.1 bc	1864 b	377 bc
VSP	20.8	3.08 a	10.4 b	6.8	4.5 ab	1907 ab	407 ab
TS	ns	**	***	ns	***	**	**
Year	***	***	***	***	***	***	***
TS x Year	ns	*	ns	ns	ns	ns	ns

TS: training system.
*,**,***,ns: significant at $p \leq 0.05$, 0.01, 0.001, or not significant, respectively.
Means separated at $p \leq 0.05$ by Duncan's multiple range test.

The relationship between reproductive and vegetative growth was determined based on the Ravaz index. GDC was the training system that showed a lowest fruit weight/pruning weight ratio, followed by SH, P and VSP. Differences on Ravaz index, with values of 3-5 fruit weight/pruning weight, did not lead to differences on sugar concentration in the must (tables 3 and 4). Statistical analysis showed a year effect on most of the variables under study, mainly due to different environmental conditions (tables 2, 3 and 4). In fact, throughout the four years the study lasted, environmental conditions were variable, with accumulated temperatures from 1500 to 1680 GDD from April to October, and annual rainfall values ranging from 900 to 1700 mm. Despite this, an interaction training system x year was observed for very few of the variables, this indicating the robustness of the differences noted among training systems, relatively independent from annual conditions.

4. Conclusion

Several training systems other than P could be used in order to modify Albariño grape composition and yield expression in the Rías Baixas Appellation area. Divided canopy training systems, such as GDC and SH, could help grapegrowers to reach similar or higher yields to the ones traditionally obtained by P, with grapes having similar sugar concentrations but lower malic acid, and higher pH. VSP led to lower yields than P, most grape composition values been intermediate between P and GDC-SH.

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